Atomic Structure -18

Full-1 [NEET] : Detailed Stepwise Solutions

Q1. Which set of quantum numbers is not allowed?
Answer: (B)

> **Conceptual Approach (Hinglish):** Quantum numbers par basic rules yaad rakho: $n = 1, 2, 3, \dots$; azimuthal $\ell = 0, 1, \dots, (n-1)$; magnetic $m = -\ell, \dots, 0, \dots, \ell$; spin $s = \pm\frac{1}{2}$. Agar $\ell = n$ aa gaya to invalid.

Solution (Stepwise):
(A) $n = 2, \ell = 1, m = 0, s = +\frac{1}{2}$ [$\ell \le n - 1 = 1$ ok] – *allowed*
(B) $n = 3, \ell = 3, \dots$ [ℓ must be $0, 1, 2$ only for $n = 3$] – **not allowed**
(C) $n = 4, \ell = 0, m = 0, s = +\frac{1}{2}$ – allowed
(D) $n = 5, \ell = 2, m = -1, s = -\frac{1}{2}$ – allowed
Hence, (B) is not allowed.

Q2. For $n = 4$, how many orbitals are possible in total?
Answer: (B)

> **Conceptual Approach (Hinglish):** Ek shell me total orbitals $= n^2$. Bas value put kar do.

Solution: $n = 4 \Rightarrow$ total orbitals $= 4^2 = 16$. **Option (B).**

Q3. Which quantum number determines the shape of the orbital?
Answer: (B)

> **Conceptual Approach (Hinglish):** Orbital ki *shape* azimuthal quantum number ℓ decide karta hai: $s(\ell = 0)$ spherical, $p(\ell = 1)$ dumbbell, $d(\ell = 2)$, $f(\ell = 3)$ etc.

Solution: Shape $\Rightarrow \ell$. **Option (B).**

Q4. According to Heisenberg uncertainty principle, $\Delta x\, \Delta p$ is of order:
Answer: (C)

> **Conceptual Approach (Hinglish):** Exact position & momentum ek saath precise nahin milte. Minimum product $\Delta x\, \Delta p \ge \frac{\hbar}{2} = \frac{h}{4\pi}$.

Solution: $\Delta x\, \Delta p \sim \frac{h}{4\pi}$. **Option (C).**

Q5. The de Broglie wavelength of an electron (mass m, velocity v) is:
Answer: (A)

> **Conceptual Approach (Hinglish):** Particle bhi wave jaisa behave karta hai: $\lambda = \frac{h}{p} = \frac{h}{mv}$ (non-relativistic).

Solution: $\lambda = h/(mv)$. **Option (A).**

Q6. Bohr radius of hydrogen atom is proportional to:
Answer: (B)

> **Conceptual Approach (Hinglish):** Bohr model: $r_n = \frac{n^2 a_0}{Z}$. Hydrogen ke liye $Z = 1$, to $r_n \propto n^2$.

Solution: $r_n \propto n^2$ (H-atom). **Option (B).**
(For H-like: $r_n \propto \frac{n^2}{Z}$)

Q7. The velocity of electron in nth Bohr orbit of H-like atom is proportional to:
Answer: (C)

Conceptual Approach (Hinglish): Bohr velocity: $v_n = \frac{Z\alpha c}{n} \Rightarrow v \propto \frac{Z}{n}$.

Solution: $v \propto Z/n$. **Option (C).**

Q8. Energy of an electron in nth orbit:
Answer: (A)

Conceptual Approach (Hinglish): Bohr energy levels: $E_n = -13.6 \frac{Z^2}{n^2}$ eV.

Solution: Exactly matches (A).

Q9. In Bohr's model, ratio of K.E to total energy of electron is:
Answer: (D)

Conceptual Approach (Hinglish): Bohr orbit me $E = \text{T.E} = -\text{K.E}$ and $\text{P.E} = 2E = -2\text{K.E}$. Isliye $\frac{\text{K.E}}{\text{T.E}} = \frac{+\text{K}}{-\text{K}} = -1$.

Solution: Ratio $= -1$. **Option (D).**

Q10. For hydrogen-like species, ionisation energy is proportional to:
Answer: (B)

Conceptual Approach (Hinglish): Ionisation energy $= |E_1| = 13.6Z^2$ eV $\Rightarrow \propto Z^2$.

Solution: $\propto Z^2$. **Option (B).**

Q11. Which spectral line is obtained when electron jumps $n = 3 \to n = 2$ (H)?
Answer: (B)

Conceptual Approach (Hinglish): $nf = 2$ series is Balmer (visible). First line $(3 \to 2) =$ Balmer-α (Hα).

Solution: Balmer-α. **Option (B).**

Q12. Rydberg constant is expressed as:
Answer: (A)

Conceptual Approach (Hinglish): Rydberg constant for H (in wavenumber): $R_H \approx 109677\,\text{cm}^{-1}$.

Solution: Option (A).

Q13. The line for transition $n = 4 \to n = 2$ belongs to:
Answer: (B)

Conceptual Approach (Hinglish): Final $n = 2 \Rightarrow$ Balmer series. ($4 \to 2$ is Balmer-β)

Solution: Balmer series. **Option (B).**

Q14. Correct relation among P.E, K.E and T.E of Bohr electron?
Answer: (D)

Conceptual Approach (Hinglish): Bohr: T.E = K.E+P.E; also P.E $= -2$K.E and K.E $= -$T.E. Teeno sahi.

Solution: All of these. Option (D).

Q15. **If $\lambda_{\text{incident}} < \lambda_0$ (threshold), photoelectric effect:**
Answer: (A)

> **Conceptual Approach (Hinglish):** Chhoti wavelength $\Rightarrow$ zyada frequency ($\nu > \nu_0$) $\Rightarrow$ photon energy $> \phi$; emission hota hai.

Solution: Occurs. **Option (A).**

Q16. **In photoelectric effect, stopping potential depends upon:**
Answer: (B)

> **Conceptual Approach (Hinglish):** $eV_s = h\nu - \phi$. Metal fixed ho to V_s sirf frequency ν par depend karta hai, intensity par nahin.

Solution: Frequency of light. **Option (B).**

Q17. **According to Planck, energy is emitted/absorbed in:**
Answer: (B)

> **Conceptual Approach (Hinglish):** Energy continuous nahin, *discrete packets* (quanta/photons) me: $E = h\nu$.

Solution: Discrete packets. **Option (B).**

Q18. **Energy of a photon of wavelength λ is:**
Answer: (A)

> **Conceptual Approach (Hinglish):** Photon energy: $E = h\nu = \dfrac{hc}{\lambda}$.

Solution: $E = hc/\lambda$. **Option (A).**

Q19. **Electromagnetic waves consist of:**
Answer: (C)

> **Conceptual Approach (Hinglish):** EM wave = time-varying, mutually perpendicular $\vec{E}$ aur $\vec{B}$ fields, propagation direction ke perpendicular.

Solution: Oscillating electric & magnetic fields. **Option (C).**

Q20. **Which of the following has maximum frequency?**
Answer: (C)

> **Conceptual Approach (Hinglish):** EM spectrum (increasing ν): Radio < Microwave < IR < Visible < UV < X-rays < Gamma. In options me X-rays sabse zyada.

Solution: X-rays. **Option (C).**

Rapid Facts (Bohr & Photon):

- $r_n = \dfrac{n^2 a_0}{Z}, \quad v_n = \dfrac{Z\alpha c}{n}$
- $E_n = -13.6\,\dfrac{Z^2}{n^2}$ eV
- T.E = K.E+P.E, P.E = −2K.E, K.E = −T.E
- $\lambda = \dfrac{h}{mv}$ (de Broglie)
- $E_\gamma = \dfrac{hc}{\lambda} = h\nu$
- Heisenberg: $\Delta x\,\Delta p \geq \dfrac{h}{4\pi}$
- Series: Lyman ($n_f = 1$), Balmer ($n_f = 2$), Paschen ($n_f = 3$), ...